Trauma Rounds

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Injuries to Duodenum, Small Intestine and Mesentery

PETER NOYES, MD:* The case for discussion today is that of a 24-year-old white man who presented with a stab wound of the abdomen. On initial examination, the patient appeared otherwise healthy and seemed to have minimal abdominal pain. There was a single 2 cm laceration of the right lower abdominal quadrant midway between the pubis and the umbilicus along the lateral border of the rectus muscle. There was some right lower quadrant abdominal tenderness. The blood pressure was 130/70 and pulse 80. The hematocrit was 43, and leukocyte count 10,300 with a normal differential.

Venous lines, one of which was a central venous pressure line, were placed in each upper extremity. Administration of Ringer's lactate was started and a Foley catheter was inserted.

The patient's condition remained stable and he was taken to the operating room one hour later. The abdomen was explored through a long midline incision. Approximately 400 ml of blood was noted to be present within the peritoneal cavity. After thorough exploration, two 1 cm longitudinal wounds of a loop of midjejunum and a 2 cm laceration of the mesentery were discovered. In addition, there was an 8 cm hematoma of the mesentery opposite another bowel laceration 20 cm distal to the first area of injury. Two proximal bowel lacerations were closed using interrupted nonabsorbable sutures. The segments of bowel and mesentery containing the hematoma were resected and an end-to-end open two-layer anastomosis carried out. The patient had an uneventful postoperative course and was discharged from the hospital on the sixth postoperative day.

F. WILLIAM BLAISDELL, MD:† *Dr. Christensen, I would like to ask you to comment on the management of injuries of the small bowel and mesentery.*

NORMAN CHRISTENSEN, MD:‡ The treatment of these injuries is generally straightforward but large wounds; avulsions of the mesentery from the intestine; blunt, multiple and duodenal injuries may present problems that tax surgical judgment. The high morbidity and mortality that follow large bowel injuries is not seen with injuries of the small intestine. Leakage from suture lines is rare. During World War II in soldiers, the leakage rate from sutured lacerations of the small intestine was approximately 1 percent. It is undoubtededly much less in civilian practice. On the other extreme, duodenal injuries are the most difficult of all gastrointestinal injuries to manage. They may be overlooked or, if identified, improperly treated—setting the scene for development of a duodenal fistula with its disastrous consequences. The mortality rate for duodenal injuries is between 10 and 15 percent. One of the reasons

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for such a high mortality rate is associated injury of nearby vital structures.

At the operating table our object is to control hemorrhage, close all perforations and remove all dead bowel. The small intestine should be eviscerated and the bowel and its mesentery carefully examined from the ligament of Treitz to the ileocecal valve. The large intestine and duodenal loop should be examined at the same time. The surgeon should count the number of perforations of the intestine. An odd number of perforations must be explained, since failure to do so may mean missing another perforation. Usually the missed perforation will lie on the mesenteric side of the bowel. Missiles can cause tangential wounds, resulting in only one perforation of the bowel, and knives or other sharp objects may penetrate only one wall of the bowel. However, most perforating wounds involve both bowel walls. Therefore, it is essential, if an odd number of perforations is seen, to be sure that you have not missed an additional perforation.

Clinical findings following both penetrating and blunt trauma to the small intestine may be minimal at first. This is because much of the small bowel content is relatively sterile and has a nearly neutral pH which may produce little inflammatory response. This is not true of injuries to the duodenum where the highly alkaline contents cause an immediate severe peritoneal response. If the duodenal injury is posterior, retroperitoneal signs may be absent. At this hospital where all penetrating wounds of the abdomen are treated by exploration, a perforating wound of the intestine is rarely, if ever, overlooked. The lag between injury and clinical manifestation of a small bowel perforation may be long and may even extend to days if expectant management is utilized.

Small bowel injury following blunt trauma may be difficult to diagnose. It must be considered even if initial signs of intraabdominal injury are absent. This is particularly true of patients who have been wearing seat belts when involved in automobile accidents. There are a number of reports in the literature describing lacerations of the mesentery which result in devascularization of a loop of bowel which did not become manifest clinically until hours or days after an auto accident.

At the time of abdominal exploration there are certain findings which, if present, require exploration of the duodenum:

- Hematoma about the duodenum, the head of the pancreas, the base of the transverse mesocolon, or at the base of the small bowel mesentery.
- Crepitation about the duodenum indicating air in the retroperitoneal tissues.
- Bile discoloration about the duodenum. This may be a dark green color or brown or so dark that true bile staining may not be identifiable.
- Fat necrosis about the duodenum.
- Edema about the duodenum.

Small wounds may be closed with a single layer of seromuscular nonabsorbable sutures. Larger wounds are more of a problem since closure may result in stenosis. If the large wound is below the ampulla of Vater, complete division of the duodenum and anastomosis to the more distal duodenum or to the jejunum may be done. If opposite the ampulla or superior to it, some other method of treatment must be used. One method is to close the wound; carry out antrectomy, vagotomy and gastrojejunostomy, and close the duodenal stump. This has been called "duodenal diverticulization" by Berne and the rationale for the procedure is diversion of gastric contents from the area of duodenal injury so as to avoid activation of pancreatic enzyme. The duodenal wound may be reinforced by a "serosal patch" thus substantially reducing the possibility of a duodenal fistula. Another method of treating a large duodenal wound is by side-to-side gastroduodenostomy using the duodenal defect as the duodenal stoma.

Duodenal injuries should be decompressed either by a nasogastric tube if no resection has been done or by catheter decompression if the wound has been severe enough to require duodenal diverticulization and construction or gastrojejunostomy.

If a duodenal hematoma is seen at the time of early exploration, it should be evacuated. It must be done gently so as to avoid converting an intramural hematoma into a perforating wound of the duodenum. If the patient is seen several days after injury, a duodenal hematoma may be suspected because of bilious vomiting, abdominal and back pain, and on rare occasions testicular pain. The diagnosis is established by the finding of a duodenal obstruction associated with the "coiled spring" sign or "stack of coins" sign in which the prominent mucosal folds show a helical pattern on x-ray contrast studies. Many duodenal hematomas will respond to nasogastric suction. A period of 10 to 12 days of conservative care is indicated. If the hematoma has not subsided by that time, operation and evacuation of the hematoma are indicated.

DR. BLAISDELL: *Dr. Christensen, would you be more specific about the nature of seat belt injuries?*

DR. CHRISTENSEN: Seat belt injuries are usually caused by compression of the bowel or the mesentery or both by the seat belt against the spinal column. Shearing caused by sudden deceleration may tear bowel from its attachments or avulse the mesentery from the bowel. Laboratory investigation has shown that rupture of the bowel occurs rarely due to increase in intraluminal pressure alone. It is probably necessary that the bowel be obstructed at two places so as to produce a closed loop if rupture is to be produced. Injuries to the lumbar spine frequently accompany seat belt injuries to the abdominal organs.

Many seat belt injuries are due to an improperly placed belt. The belt lies across the abdomen rather than across the pelvis, or at the time of the accident the patient slips underneath the belt and the force is applied to the abdomen. A big problem with seat belt injuries is making the diagnosis. Physical findings may be minimal at first, and a number of cases are reported in the literature in which the diagnosis was delayed for several days. One reason for this is that the injury is primarily mesenteric and produces devascularization of a segment of small bowel rather than immediate rupture.

DR. BLAISDELL: *Would you please be specific on at what point in perforating injuries you would elect to resect the bowel? I realize it is a matter of judgment, but do you have a rule of thumb that we could use to work with?*

DR. CHRISTENSEN: When the diameter of the lacerations in a given segment of bowel equals the diameter of the bowel you have a clear indication for resection and anastomosis. If we had to sew up four 1 cm lacerations of the bowel and the circumference of the bowel was 4 cm, that would be clear-cut indication to resect and anastomose. In gunshot wounds in which there is a need to debride, by the time you have completed your debridement you may have a wound large enough to warrant resection and anastomosis. When doing an anastomosis you can see what you are doing, you can get rid of devitalized bowel. If you elect to close large wounds, you may not be able to see what the mucosa looks like and you probably have a greater potential for a breakdown. The only area where I would be conservative would be in the duodenum and the terminal ileum. The ileocecal valve has important anatomical functions and many absorptive functions are found in the distal ileum.

DR. BLAISDELL: *Would you describe the incision you use for exploratory laparotomy?*

DR. CHRISTENSEN: The standard incision is a midline laparotomy incision. We can miss holes if our laparotomy wounds are too small, for, as a consequence, it is difficult to carry out an adequate exploration. Any missed perforation of the small bowel may mean a fatality in an otherwise good-risk, young, healthy patient. It is my opinion that far more complications result from missed perforations than from breakdown of a small bowel closure or anastomosis. The good blood supply of the small intestine combined with low bacterial counts in the lumen result in prompt healing as a general rule.

A PHYSICIAN: *Dr. Christensen, would you describe in more detail how you place sutures for closure of small bowel lacerations and how you carry out small bowel anastomosis?*

DR. CHRISTENSEN: I use a one-layer closure consisting of nonabsorbable sutures. A purse string can be used to close small perforations. For larger wounds I use interrupted seromuscular Lembert sutures. In doing an anastomosis I first cut the bowel back to healthy bleeding mucosa and then apply a Carmalt, Allen or other intestinal clamp obliquely across the bowel ends with the tip of the clamp directed to the mesenteric border. The clamp should be angled so that the bowel when divided will be longer on the mesenteric side than on the antimesenteric side. I then place a seromuscular, nonabsorbable 3-0 or 4-0 suture between the ends of the bowel on the mesenteric border. It is important to have the border cleared of fat. The next suture is placed opposite the first on the antimesenteric borders of the bowel. A row of similar sutures is then placed between the first two sutures completing one suture line. Then with a knife I cut adjacent to the clamps removing the crushed bowel and opening the lumen of the loops. The anastomosis is completed by placing an anterior row of sutures in the same manner as the posterior row was placed.

DR. BLAISDELL: *Dr. Christensen, how do you manage injuries to the mesentery when there is a large mesenteric hematoma? How do you close lacerations of the mesentery?*

DR. CHRISTENSEN: Large hematomas of the mesentery should be explored since the superior mesenteric artery or one of its major branches may be involved. Hemorrhage can generally be controlled by pressure. After evacuating the hematoma, small bleeding vessels may be ligated. Injuries to larger arteries should be repaired, if feasible, to avoid ischemia of the bowel, and therefore, bleeding vessels should not be crushed and ligated before they are fully identified. Mesenteric rents should be closed by continuous or interrupted sutures placed with care so as to avoid further injury to blood vessels.

A PHYSICIAN: *How do you determine viability of the bowel when there has been mesenteric vascular injury? How do you determine how much small intestine to resect?*

DR. CHRISTENSEN: If the bowel has a normal appearance and responds to pinching with peristalsis, it is viable. If it is dusky on the outside the mucosa is probably dead or dying and resection is indicated. Hypovolemia causes poor perfusion and it is important to restore blood volume when trying to determine whether or not bowel is viable. Pulsations in the small vessels of the arcades should be felt for and if present indicate that the bowel will probably remain viable even though it may not look healthy when you first see it.

If you have to resect, the resection should be carried back to where the wall of the bowel including the mucosa bleeds. That is why an open anastomosis is optimal.

If mesenteric injury results in extensive resection being necessary, and at the time of closure there is any question about the viability of the remaining bowel, a second look 24 hours later is indicated. This permits removal of any residual peritoneal blood and resection of marginal appearing segments of the bowel back to bleeding mucosa. This permits a maximal amount of bowel to be salvaged with minimal risk to small bowel fistulae.

DR. BLAISDELL: I think we will close the discussion on that last point. Review of our series of gastrointestinal injuries time and again reinforces Dr. Christensen's statement. When there is any doubt about hemostasis or viability of bowel, reoperation within 24 hours is mandatory. Patients tolerate repeated laparotomy well. They do not tolerate bowel disruption or leakage, and these complications are the ones that lead to fatality.